Orbital Selective Localization and Other Unusual Phenomena in Iron Chalcogenides

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The evolution of the electronic structure from localized to itinerant is a fundamental problem in condensed-matter physics and relevant to many interesting materials. Iron chalcogenides belong to the class of multi-orbital systems with important Hund's interaction, what results in an unusual effect of orbital selective localization, in which some orbitals become localized while others remain itinerant. This phenomenon, leading to so-called orbital selective Mott phase (OSMP), has been documented recently in iron chalcogenides by angular resolved photoemission (ARPES) [1]. It is accompanied by a wealth of other unusual phenomena, including unconventional superconductivity, magnetic fluctuations with or without long-range magnetic order, and nematicity.

In this talk, after introduction describing the most important features uncovered so far in iron chalcogenides, I will summarize several years of our studies of iron chalcogenide system, $FeTe_{1-x}Se_x$, with substitution of Ni into Fe sites [2-4]. The substitution modifies the electronic structure of this compound, as directly confirmed by ARPES [3], what facilitates observation of the transition to the OSMP with increasing temperature by magnetotransport experiments [2, 4]. Another interesting feature, observed by angular magnetoresistance [4], is the development of spin nematicity induced by Ni doping. This effect is strongly influenced by the microstructural disorder existing in the crystals, and likely contributes to the suppression of superconductivity in this system.

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